Onset of Dormancy in the Copepod *Calanus pacificus californicus* off Southern California

David M. Checkley, Jr.
Integrative Oceanography Division
Scripps Institution of Oceanography
La Jolla, CA 92993-0218
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This grant supported the Ph.D. dissertation research of Catherine L. Johnson. Dr. Johnson was awarded her Ph.D. in May 2003 from the University of California, San Diego. Hereafter, 'we' refers to Drs. Johnson and Checkley.

Our object in this work was to examine the onset of dormancy in the marine, planktonic copepod, *Calanus pacificus californicus*. Planktonic copepods, of which *C. pacificus* is a dominant species, may be the ocean's most numerous multicellular organism. Copepods form aggregations in the sea that are significant in regard to acoustics, ecology, fisheries, and biogeochemistry. A long-term objective of our work is to understand, and thus predict, the occurrence of such aggregations. Dormancy, or a period of arrested development (ca. hibernation) at depth, is common in *Calanus* and many other genera of copepods. Understanding the factors that control onset of and emergence from dormancy in such species is critical to modeling their population dynamics, predicting the timing of buildup and dispersal of subsurface aggregation of dormant copepods, and predicting changes in dormancy response resulting from climate change. The research conducted under this grant examined the onset of and emergence from dormancy of *C. pacificus californicus* and its distribution at depth during dormancy in the region off Southern California. A novel method using hormonal differences between dormant and active individuals was developed to examine preparation for dormancy.

The vertical distribution and abundance of dormant *C. pacificus* were described over eleven months at San Diego Trough (SDT) and at basin and open-water stations during three months. The abundance of dormant *C. pacificus* at SDT increased from June to October, and decreased from October until March. Variation in molting hormones was characterized through the CV molt cycle, and both molting-hormone level and jaw phase morphology were used to examine changes in molt phase indicating onset of dormancy in surface CVs. Although differences in mean molt-phase indices between the period of increasing deep CV abundance and other dates suggested onset of dormancy in surface water when deep CV abundance was increasing, variability in molt-phase indices among dates suggested a heterogeneous dormancy response in surface CVs. The observed dormancy response did not support hypotheses that either photoperiod or food limitation alone induces dormancy.

Dormant copepods were present at all stations examined between June and January. At SDT, they occupied the California Undercurrent at the beginning and end of the dormant period, indicating a poleward transport for part of the year. The abundance of dormant CVs was not different in basin and open-water stations.

Primary results of this work include:

- Development of a new method, using molting hormones, to detect preparation for dormancy by copepods
- Documentation of the distribution and abundance, both vertically and horizontally, of dormant *Calanus pacificus californicus*, the dominant calanoid copepod off California
- A better understanding of the ecology and population dynamics of *C. pacificus*

These results are germane to copepods elsewhere in the world.

Dr. Johnson will next put the knowledge gained in this work to use in modeling the population dynamics of marine copepod that exhibit dormancy. This work, funded by the National Science Foundation, will lead to a better understanding and prediction of the distribution, abundance, and ecology of marine planktonic copepods.

Publications and Presentations

Johnson, C.L.. In press. Ecdysteroids in an oceanic copepod, *Calanus pacificus*: variation through the molt cycle and change associated with diapause: Marine Ecology Progress Series.

Johnson, C.L. 2003. Dormancy in an Eastern Boundary Current Copepod. Ph.D. Dissertation, University of California San Diego, La Jolla, California. 149pp.

Johnson, C.L. 2003. Sources of dormant *Calanus pacificus* in the Southern California Bight, Third International Zooplankton Production Symposium, Gijón, Spain (oral)

Johnson, C.L. 2002. Onset of dormancy in the copepod Calanus pacificus in the Southern California Bight: timing of descent, indicators of preparation for dormancy, and environmental conditions. Ocean Sciences Meeting, Honolulu, Hawaii. (oral)

Johnson, C.L., and J.M. Gendron. 2001. Vertical distribution of dormant *Calanus pacificus* in basins and deep water off southern California. American Society of Limnology and Oceanography, Albuquerque, New Mexico (poster)

Manuscripts in Preparation

Johnson, C.L.. Seasonal variation in the vertical distribution and mold status of *Calanus pacificus*, a planktonic copepod, off southern California.

Johnson, C.L.. Abundance and distribution of dormant *Calanus pacificus* in basins and deep, open water off southern California.

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Scripps Institution of Oceanography
Integrative Oceanography Division
9500 Gilman Drive
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Attn: Dr. James Eckman, Code 322BC
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14. ABSTRACT

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